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COUNTERBALANCE UNIT****Publication Classification**(71) Applicants: **KOHYOUNG TECHNOLOGY INC.**,
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Ansan-si (KR)(52) **U.S. Cl.**
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(2013.01); **A61B 2090/504** (2016.02)(21) Appl. No.: **14/372,882**(22) PCT Filed: **May 23, 2014**(86) PCT No.: **PCT/KR2014/004649**

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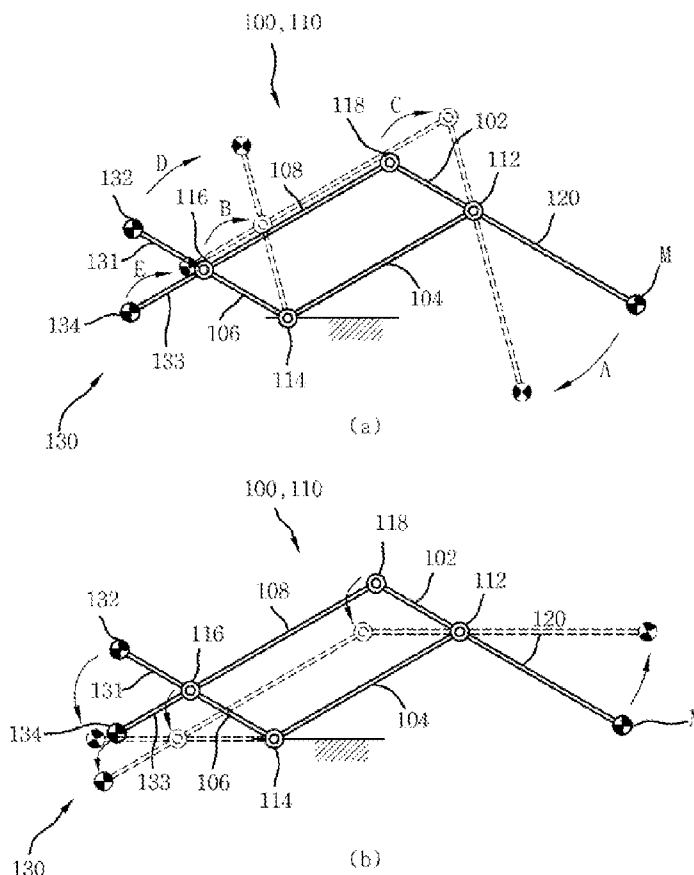
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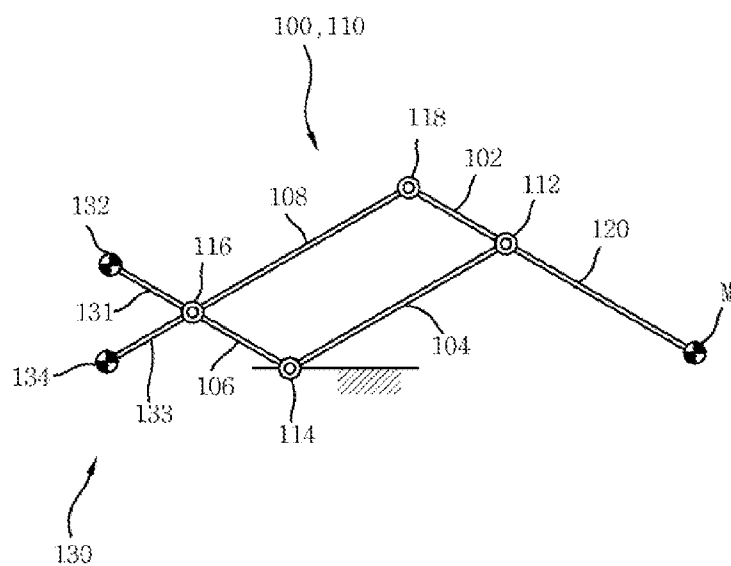
May 22, 2014 (KR) 10-2014-0061915

(57) **ABSTRACT**

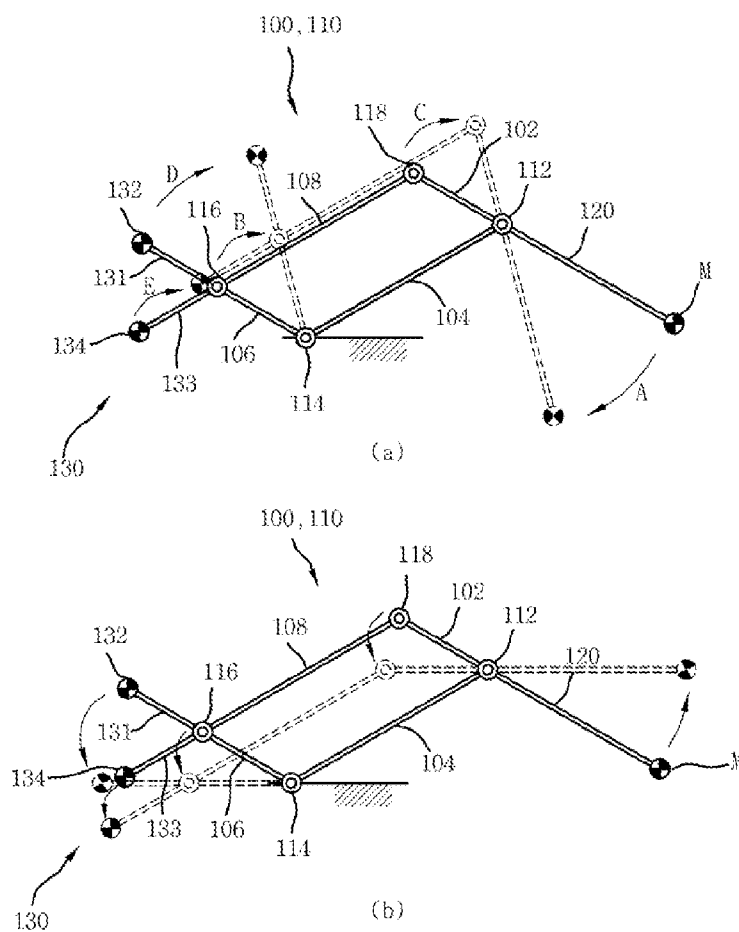
The present invention relates to a stand equipped with a counterbalance unit, i.e., a stand consisting of links, joints, a front link, and a counterbalance unit. Therefore, even when various medical apparatuses including such as a microscope, etc. are used, a stable counterbalance can be maintained and the degree of freedom of movements of the medical apparatus can be easily adjusted according to the purpose of users.



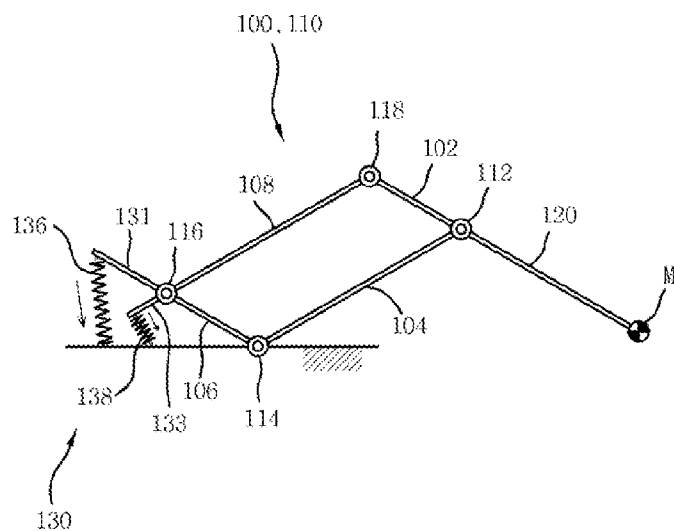
[Fig. 1]



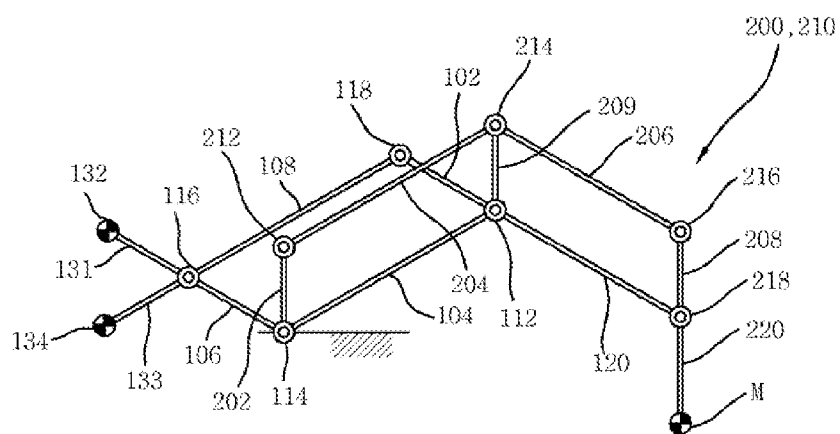
[Fig. 2]



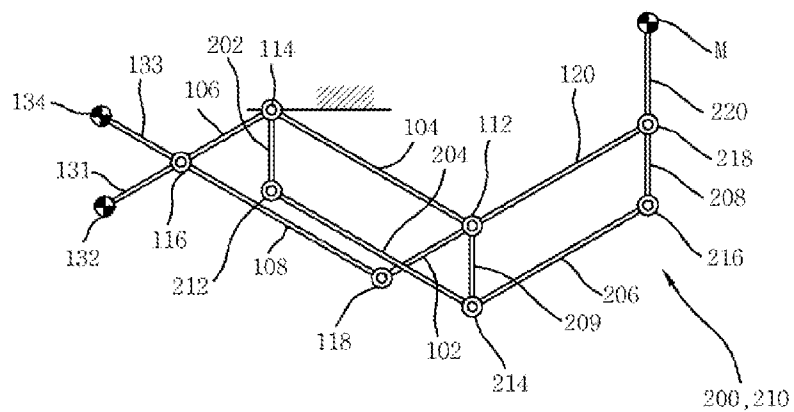
[Fig. 3]



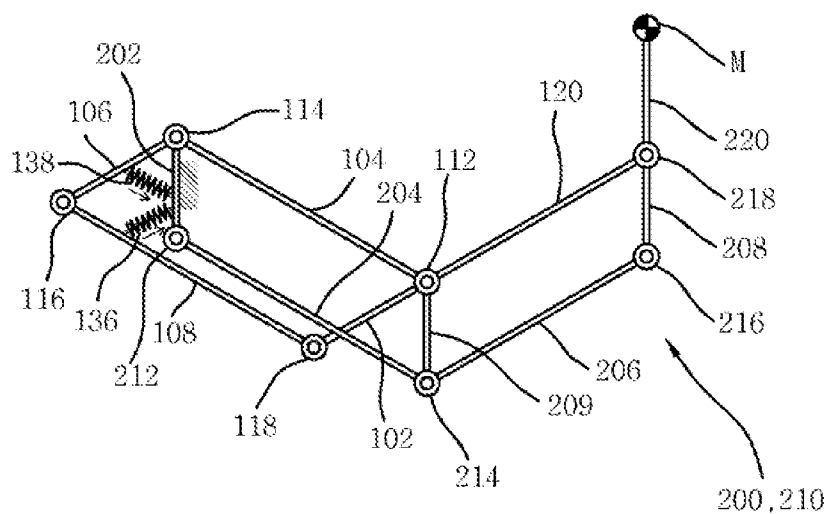
[Fig. 4]



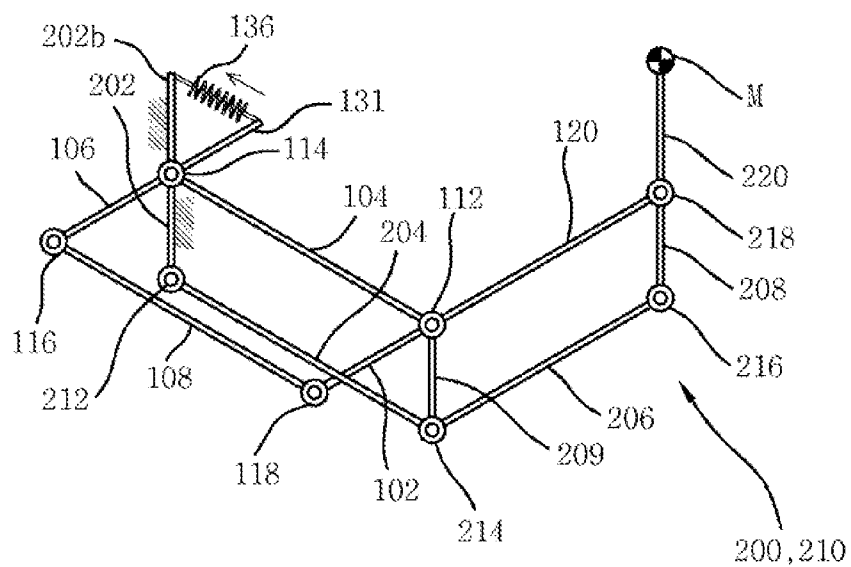
[Fig. 5]



[Fig. 8]



[Fig. 9]



STAND EQUIPPED WITH COUNTERBALANCE UNIT

TECHNICAL FIELD

[0001] The present invention relates to a stand equipped with a counterbalance unit, more particularly, a stand equipped with a counterbalance unit wherein a medical apparatus such as a microscope and a surgical end effector can be installed and moved to a desired position.

BACKGROUND ART

[0002] Microsurgery, in which a medical surgical microscope is used to observe affected parts while performing surgery, has been studied and introduced in the surgical operation field.

[0003] In such microsurgery, a stand is needed to install weighty objects, i.e., a surgical microscope with its attached devices; place them in a desired space; then maintain their position.

[0004] Generally, in the balance structure of such a stand, the middle part of a link unit using a parallel link is rotatably connected to a holding unit, while a surgical microscope is installed at one end of the link unit and a counterweight is placed at the other end of the link unit, centered on the point of rotation, in order to offset the weight of the surgical microscope.

[0005] Since a surgical microscope is mounted with attachments such as an assistant scope or a video camera, etc., the position of a counterweight is adjusted based on the total weight of the surgical microscope to maintain the overall balance between the surgical microscope and the counterweight.

[0006] However, in case when a surgical microscope and its attached devices remain in the desired position, their vertical balance needs to be maintained, but a conventional stand has difficulties to control the vertical balance due to the inconsistent total weight of a surgical microscope by the presence of various attachments.

DISCLOSURE

Technical Problem

[0007] The present invention is devised to solve the problem stated above, therefore an object of the present invention is to provide a stand equipped with a counterbalance unit capable of maintaining a reliable and efficient counterbalance regardless positions of a medical apparatus.

[0008] Another object of the present invention is to provide a stand equipped with a replaceable counterweight based on the size of torque in joints caused by a medical apparatus, and a counterbalance unit capable of adjusting the length of a balance link.

[0009] The other object of the present invention is to provide a stand equipped with a counterbalance unit capable of enhancing degree of freedom easily.

Technical Solution

[0010] In order to achieve the objects herein, a stand equipped with a counterbalance unit according to the present invention is composed of the following technical properties: four links arranged in a square configuration; four joints that are connected to each connection part of the four links independently and enable these links to be mutually rotatable; a

front link that is extended from an end of any one of the four links and mounted with a medical apparatus at the end; a counterbalance unit connected to a joint that is diagonally located from the joint from where the front link is extended.

Advantageous Effects

[0011] A stand equipped with a counterbalance unit according to the present invention can obtain a large torque compensation effect with small weight by optimizing the mounting position of counterbalance.

[0012] In addition, even when a number of medical apparatus such as a microscope and the like are used, because of a replaceable counterweight based on the size of torque in joints caused by a medical apparatus and a counterbalance unit capable of adjusting the length of a balance link, a reliable and efficient counterbalance can be maintained.

[0013] Moreover, depending upon the purpose of a user, multiple extension link members can be installed to improve the degree of freedom of the movement of a medical apparatus.

DESCRIPTION OF DRAWINGS

[0014] FIG. 1 is a schematic diagram illustrating a stand equipped with a counterbalance unit according to the present invention.

[0015] FIG. 2 is schematic diagrams illustrating FIG. 1 in operation modes.

[0016] FIG. 3 is a schematic diagram illustrating an embodiment of a counterbalance unit.

[0017] FIG. 4 is a schematic diagram illustrating a stand equipped with extension link members.

[0018] FIG. 5 is a schematic diagram illustrating another embodiment of FIG. 4.

[0019] FIG. 6 is schematic diagrams illustrating FIG. 5 in operation modes.

[0020] FIG. 7 to FIG. 9 are schematic diagrams illustrating various embodiments of a counterbalance unit.

BEST MODE

[0021] Hereinafter, more detailed description of a stand equipped with a counterbalance unit according to the present invention is provided by using appended drawings.

[0022] The present invention relates to a stand equipped with a counterbalance unit, wherein FIG. 1 is a schematic diagram illustrating a stand equipped with a counterbalance unit according to the present invention, FIG. 2 is schematic diagrams illustrating FIG. 1 in operation modes, and FIG. 3 is a schematic diagram illustrating an embodiment of a counterbalance unit.

[0023] A stand equipped with a counterbalance unit according to the present invention is composed of four links **100** arranged in a square configuration; four joints **110** that are connected to each connection part of the four links **100** independently and enable these links **100** to be mutually rotatable; a front link **120** that is extended from an end of any one of the four links **100** and mounted with a medical apparatus **M** at the end; a counterbalance unit **130** connected to a joint **110** that is diagonally located from the joint **110** from where the front link **120** is extended.

[0024] Each component is described in more details as follows.

[0025] Joints **110** consist of the first, second, third, and fourth joints **112**, **114**, **116**, **118** and are connected to each

connection part of the four links **100** independently so that the links **100** are mutually rotatable.

[0026] Links **100** consist of the first link **102** whose both ends are connected to the first and fourth joints **112**, **118**; the third link **106** whose both ends are connected to the second and third joints **114**, **116** and placed on the opposite side of the first link **102**; the second link **104** whose both ends are connected to the first and second joints **112**, **114**; the fourth link **108** whose both ends are connected to the third and fourth joints **116**, **118** and placed on the opposite side of the second link **104**. The links are arranged in a square configuration, but it is preferable to be arranged in a parallelogram configuration as illustrated in FIG. 1. For simplicity, the description hereinafter relates to an embodiment in which links **100** are arranged in a parallelogram configuration. In case of which links **100** are not formed in a parallelogram configuration, parallel can be understood as subtended.

[0027] Both ends of the first link **102** are connected to the first and fourth joints **112**, **118**, while the third link **106** located in parallel to the first link **102** has its both ends connected to the second and third joints **114**, **116**. In addition, both ends of the second link **104** are connected to the first and second joints **112**, **114**, while the fourth link **108** located in parallel to the second link **104** has its both ends connected to the second and third joints **114**, **116**. Accordingly, the first, second, third, and fourth links **102**, **104**, **106**, **108** are mutually rotatable and thus a medical apparatus M which will be described later is to have the degree of freedom.

[0028] Meanwhile, four joints **110** has at least any one of them fixed to a holding unit(not shown) to be supported, and in case of an embodiment of the present invention, the second joint **114** is fixed to a holding unit to be supported.

[0029] A front link **120**, extended from any one end of the four links **100** and mounted with a medical apparatus M at the end, moves the medical apparatus M according to the movement of the links **100** which is interlocked to the front link. In the embodiment of the present invention, it is set to be that a front link **120** is extended from an end of the first link **102** as illustrated in FIG. 1, and the first joint **112** is connected between the first link **102** and the front link **120**.

[0030] A counterbalance unit **130** is connected to a joint **110** placed in a diagonal direction from the joint **110** that is located at the extension part from where a front link **120** is extended, and functions to counterbalance a medical apparatus M. That is, according to the embodiment of links **100**, as illustrated in FIG. 1, the first joint **112** is placed at the extension part from where a front link **120** is extended, and the third joint **116** is positioned in the diagonal direction from the first joint **112**, thus a counterbalance unit **130** is connected to the third joint **116**.

[0031] The counterbalance unit **130** in the present invention can use weighter and springs to balance against a front link **120** with a medical apparatus M. Hereinafter, the description of the case using weighter will come first.

[0032] A counterbalance unit **130** is composed of two links **100** connected to the third joint **116**, i.e., the first and second balancing links **131**, **133** extended from the third and fourth links **106**, **108**; the first and second counterweights **132**, **134** independently mounted at the end of the first and second balancing links **131**, **133**. Accordingly, the first and second counterweights **132**, **134** are placed on the opposite side of a medical apparatus M, centering the second joint **114**, to maintain balance, and in case when the medical apparatus M moves to the direction contrary to gravity, the first and second

counterweights **132**, **134** move to the direction of gravitational force in order to compensate the torque in joints caused by the medical apparatus. Since a counterbalance unit **130** is connected to the third joint **116** as illustrated in FIG. 1 instead of to the second joint **114** that is functioning as the central axis, the effective distance to the central axis (the distance between the central axis and the gravity vector functioning in the counterweights) is maximized in most movements of links **100**, and thus the torque in joints generated by the medical apparatus can be compensated in full.

[0033] Meanwhile, the length of the first and second balancing links **131**, **133** is adjustable, and each of the first and second counterweights **132**, **134** is removably installed on the first and second balancing links **131**, **133** respectively, thus the compensated torque in joints can be controlled in accordance with the length of a front link **120** or the weight of a medical apparatus M.

[0034] A counterbalance unit **130** in another embodiment is composed of the first and second balancing links **131**, **133** extended from the third and fourth links **106**, **108**; the first and second counter springs **136**, **138** attached to the tip of the first and second balancing links **131**, **133** respectively. For reference, a holding unit fixing the second joint **114** is extended in parallel with the ground. And as illustrated in FIG. 3, one end of the first counter spring **136** is connected to the tip of the first balancing link **131**, while the other end is connected to the holding unit. In this case, the first counter spring **136** is a tension spring that moves the first balancing link **131** to gravity direction which is the direction of the arrow in order to compensate the torque in joints generated by a medical apparatus M. One end of the second counter spring **138** is connected to the tip of the second balancing link **133**, while the other end is connected to the holding unit. The second counter spring **138** is also a tension spring and it moves the second balancing link **133** to the direction of the arrow in order to compensate the torque in joints generated by a medical apparatus M.

[0035] Also, one end of the counter spring can be connected to the third link **106**, while the other end is connected to the holding unit when necessary.

[0036] Hereinafter, the operation mode of a stand equipped with a counterbalance unit according to the present invention will be described by using appended drawings.

[0037] Referring to FIG. 2(a), when a medical apparatus M moves to the direction A complying with gravity, due to the structure of links **100**, each of the third and fourth joints **116**, **118** moves to the direction B and C respectively, therefore, the first and second counterweights **132**, **134** independently move to the direction D and E contrary to the direction of gravity. Consequently, the potential energy of the first and second counterweights **132**, **134** increases, therefore, less force is required for the medical apparatus M to return to its original position or move to other positions as illustrated in FIG. 2(b).

[0038] Conversely as illustrated in FIG. 2(b), when a medical apparatus M moves to a direction against gravity, the links **100** function to the opposite direction from FIG. 2(a), which leads the first and second counterweights **132**, **134** to move conforming to gravity, thus decreases the potential energy while enabling to move the medical apparatus M against gravity using only little force.

[0039] FIG. 4 is a schematic diagram illustrating a stand equipped with extension link members; FIG. 5 is a schematic

diagram illustrating another embodiment of FIG. 4; FIG. 6 is schematic diagrams illustrating FIG. 5 in operation modes.

[0040] Extension link members are composed of extension links 200 connected to links 100 and a front link 120; extension joints 210 connected to each connection part of the extension links 200 respectively and capable of extension links 200 to be mutually rotatable; an extension front link 220 extended from an end of the extension link 200 that is one of extension links 200 and connected to the front link 120, thereby function to improve the degree of freedom of a medical apparatus M.

[0041] Extension joints 210 are composed of the first, second, third, and fourth extension joints 212, 214, 216, 218.

[0042] Extension links 200 are placed on the opposite side of the second link 104 and composed of the second extension link 204 whose both ends are connected to the first and second extension joints 212, 214; the third extension link 206 placed on the opposite side of a front link 120 and having its one end connected to the second extension joint 214 while the other end is connected to the third extension joint 216; the first extension link 202 whose both ends are independently connected to the second joint 114 and the first extension joint 212; the fourth extension link 208 whose one end is connected to the third extension joint 216 while the other end is connected to the fourth extension joint 218; the fifth extension link 209 whose both ends are independently connected to the first joint 112 and the second extension joint 214.

[0043] In extension link members illustrated in FIG. 4, each of the second and third extension links 204, 206 is placed in parallel with the second link 104 and a front link 120 respectively, and one ends of the second and third extension links 204, 206 are connected to each other through the second extension joint 214, while the other end of the second extension link 204 is connected to the first extension joint 212 and the other end of the third extension link 206 is connected to the third extension joint 216. In addition, the both ends of the first extension link 202 are connected to the second joint 114 and the first extension joint 212, and the both ends of the fourth extension link 208 are connected to the third extension joint 216 and the fourth extension joint 218, while the both ends of the fifth extension link 209 are connected to the first joint 112 and the second extension joint 214. That is, extension links 200 having the shape of two overlapped parallelograms are extended from the center point that is the second joint 114.

[0044] Also, the first extension link 202 can be fixed perpendicularly to the installation surface in order to maintain an extension front link 220, which will be described later, to be vertical. In other words, since the first extension link 202 and the fifth extension link 209 are always in parallel while the fifth extension link 209 and the fourth extension link 208 are always in parallel, an extension front link 220 extended from the fourth extension link 208 is likewise in parallel with the first extension link 202 all the time. Accordingly, in case of which a medical apparatus M such as a microscope should always remain vertical, the medical apparatus M can always remain vertical by fixing the first extension link 202 perpendicularly to the installation surface.

[0045] An extension front link 220 is extended from the fourth extension link 208, and has a medical apparatus M mounted at the tip of it. After all, extension links 200 are the supplementary means to bring the connection of the extension front link 220 and it is the extension front link 220 that interlocks the medical apparatus M with movements of links

100 as well as movements of extension link members to increase the degree of freedom.

[0046] Meanwhile, as illustrated in FIG. 5, a stand equipped with a counterbalance unit according to the present invention can be formed in the shape in which the top and the bottom of FIG. 4 are inverted. In case when a medical apparatus M functions from bottom to top, e.g., such as an objective lens of a microscope is in use, similarly, as illustrated in FIG. 6(a) and FIG. 6(b), the first extension link 202 can be fixed perpendicularly towards the ground in order for the extension front link 220 always to remain vertical while moving.

[0047] FIG. 7 to FIG. 9 are schematic diagrams illustrating various embodiments of a counterbalance unit.

[0048] Hereinafter, a stand equipped with extension link members with the application of counter springs is described using appended drawings.

[0049] First, referring to FIG. 7, there provided the first and second balancing links 131, 133 extended from the third and fourth links 106, 108; the first and the second auxiliary links 202a, 202b extended from the first extension link 202, and the first and second auxiliary links 202a, 202b are fixed perpendicularly towards the ground like the first extension link 202. And one end of the first counter spring 136 is connected to the tip of the first balancing link 131, while the other end is connected to the first auxiliary link 202a. In this case, the first counter spring 136 is a tension spring and moves the first balancing link 131 to the gravitational direction, i.e. the direction of the arrow, to compensate torque in joints created by a medical apparatus M. The one end of the second counter spring 138 is connected to the tip of the second balancing link 133, while the other end is connected to the second auxiliary link 202b. In this case, the second counter spring 138 is a tension spring and moves the second balancing link 133 to the direction of the arrow to compensate torque in joints created by a medical apparatus M.

[0050] Referring to FIG. 8 as another embodiment, one end of the first counter spring 136 is connected to the fourth link 108, while the other end is connected to the first extension link 202. One end of the second counter spring 138 is connected to the third link 106, while the other end is connected to the first extension link 202. The first and second counter springs 136, 138 are tension springs and each of them moves the fourth link 108 and the third link 106 to the directions of the arrows respectively to compensate torque in joints created by a medical apparatus M.

[0051] Referring to FIG. 9 as the other embodiment, the second auxiliary link 202b is extended from the first extension link 202, and the first balancing link 131 is extended from the third link 106 connected to the second joint 114. One end of the first counter spring 136 is connected to the first balancing link 131, while the other end is connected to the second auxiliary link 202b. In this case, the first counter spring 136 is a tension spring, and moves the first balancing link 131 to the direction of the arrow to compensate torque in joints created by a medical apparatus M.

[0052] Thus, in case of which counter springs are applied to a stand equipped with extension link members, various embodiments can be configured. For the greater variety of embodiments, counter springs that are directly connected to links 100 or extension links 200 as well as additional balancing links upon the necessity can be provided.

[0053] Meanwhile, more extension link members can be mounted upon the necessity. An additional link is connected

to the second joint **114** supported by a holding unit; a link is connected in parallel with the second link **104**; more links are connected, wherein each of the links is in parallel with a front link **120** and an extension front link **220** respectively. Next, an additional front link is connected to the extension front link **220** and then a medical apparatus is mounted at the tip of the connected front link. In the same manner as above, N number of extension link members can be additionally mounted in order to variously set the degree of freedom of medical apparatus.

[0054] And as the number of extension link members increases, a medical apparatus M gets further from the second joint **114** that is the center point of rotation, accordingly, the torque in joints generated by the medical apparatus M grows bigger. In order to maintain a stable counterbalance, it is desirable that the length of the first and second balancing links **131**, **133** increases proportion to the growing number of extension link members. For the efficient counter balance, it is more preferable to increase the weight of the first and second counterweights **132**, **134** as well as the length of the first and second balancing links **131**, **133**.

DETAILED DESCRIPTION OF MAIN ELEMENTS

[0055] **100**: link
 [0056] **102**: the first link
 [0057] **104**: the second link
 [0058] **106**: the third link
 [0059] **108**: the fourth link
 [0060] **110**: joint
 [0061] **112**: the first joint
 [0062] **114**: the second joint
 [0063] **116**: the third joint
 [0064] **118**: the fourth joint
 [0065] **120**: front link
 [0066] **130**: counterbalance unit
 [0067] **131**: the first balancing link
 [0068] **132**: the first counterweight
 [0069] **133**: the second balancing link
 [0070] **134**: the second counterweight
 [0071] **136**: the first counter spring
 [0072] **138**: the second counter spring
 [0073] **200**: extension link
 [0074] **202**: the first extension link
 [0075] **202a**: the first auxiliary link
 [0076] **202b**: the second auxiliary link
 [0077] **204**: the second extension link
 [0078] **206**: the third extension link
 [0079] **208**: the fourth extension link
 [0080] **209**: the fifth extension link
 [0081] **210**: extension joint
 [0082] **212**: the first extension joint
 [0083] **214**: the second extension joint
 [0084] **216**: the third extension joint
 [0085] **218**: the fourth extension joint
 [0086] **220**: extension front link

1. A stand equipped with a counterbalance unit, comprising:

- four links arranged in a square configuration;
- four joints, wherein each of the joints is connected to each connection part of the four links respectively, and enable these links to be mutually rotatable;

a front link that is extended from an end of any one of the four links and mounted with a medical apparatus at the tip;

a counterbalance unit connected to a joint that is diagonally located from the joint from where the front link is extended.

2. The stand equipped with a counterbalance unit of claim 1, wherein the joints consist of the first, second, third, and fourth joints, and the links are comprised of
 - the first link whose both ends are connected to the first and fourth joints;
 - the third link that is placed on the opposite side of the first link, and both ends of the third link are connected to the second and third joints;
 - the second link whose both ends are connected to the first and the second joints;
 - the fourth link that is placed on the opposite side of the second link, and both ends of the fourth link are connected to the third and fourth joints, and
 - the front link is extended from the first link and connected to the first joint.
3. The stand equipped with a counterbalance unit of claim 1, wherein the links are arranged in a parallelogram configuration.

4. The stand equipped with a counterbalance unit of claim 2, comprising:

extension links consisting of including additional extension link members that increase the degree of freedom of the medical apparatus, and the extension link members are connected to the links and the front link;

extension joints, wherein each of them is connected to each connection part of the extension links respectively, and enable these extension links to be mutually rotatable;

an extension front link that is extended from an end of any one of the extension links which is connected to the front link, and

the medical apparatus is mounted at the tip of the extension front link.

5. The stand equipped with a counterbalance unit of claim 2, wherein the counterbalance unit consists of including the first and second counterweights that are independently mounted at the first and second balancing links, as well as the tip of these first and second balancing links.

6. The stand equipped with a counterbalance unit of claim 5, wherein the first and second balancing links are connected to the third joint, and each of these balancing links is extended and formed from the third and fourth links respectively.

7. The stand equipped with a counterbalance unit of claim 5, wherein the length of the first and second balancing links is adjustable.

8. The stand equipped with a counterbalance unit of claim 5, wherein each the first and second counterweights is removably mounted on the first and second balancing links respectively.

9. The stand equipped with a counterbalance unit of claim 2, wherein the counterbalance unit consists of the first and second balancing links, as well as the first and second counter springs separately attached to the first and second balancing links to exert attractive or repulsive forces.

10. The stand equipped with a counterbalance unit of claim 4, wherein the extension joints consist of the first, second, third, and fourth extension joints, and

the extension links are comprised of
the second extension link that is placed on the opposite side of the second link, and both ends of the second extension link are connected to the first and second extension joints;
the third extension link that is placed on the opposite side of the front link, and one end of the third extension link is connected to the second extension joint while the other end is connected to the third extension joint;
the first extension link whose both ends are connected to the second joint and the first extension joint;
the fourth extension link whose one end is connected to the third extension joint while the other end is connected to the fourth extension joint;
the fifth extension link whose both ends are connected to the first joint and the second extension joint, and
the extension front link is extended from one end of the fourth extension link.

11. The stand equipped with a counterbalance unit of claim 10, wherein the first extension link is fixed perpendicularly to the installation surface.

12. The stand equipped with a counterbalance unit of claim 11,
wherein the first extension link is comprised of
the first auxiliary link that is connected to the first extension joint and extended from the first extension link;

the second auxiliary link that is connected to the second joint and extended from the first extension link, and
the counterbalance unit is comprised of
the first and second balancing links that are connected to the third joint and each of these balancing links is extended and formed from the third and fourth links respectively;
the first and second counter springs, wherein each of them is separately connected to the first auxiliary link and the first balancing link, as well as the second auxiliary link and the second balancing link.

13. The stand equipped with a counterbalance unit of claim 2, wherein the links are arranged in a parallelogram configuration.

14. The stand equipped with a counterbalance unit of claim 4, wherein the counterbalance unit consists of including the first and second counterweights that are independently mounted at the first and second balancing links, as well as the tip of these first and second balancing links.

15. The stand equipped with a counterbalance unit of claim 4, wherein the counterbalance unit consists of the first and second balancing links, as well as the first and second counter springs separately attached to the first and second balancing links to exert attractive or repulsive forces.

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